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Final Technical Report

15 August 1999 - 14 August 2002

"Louisiana NASA EPSCoR Preparation Grant"

**NASA Cooperative Agreement
NCC5-393**

**John P. Wefel
Principal Investigator/Project Director
Department of Physics and Astronomy
Louisiana State University
Baton Rouge, LA 70803-4001
225-578-8697**

and

**E. Joseph Savoie
Commissioner of Higher Education
Louisiana Board of Regents
P.O. Box 3677
Baton Rouge, LA 70821-3677
225-342-4253**

SUMMARY

In August, 1999, the National Aeronautics and Space Administration issued a Cooperative Agreement (CA) to the State of Louisiana, through the Louisiana Board of Regents (BOR), for the performance of scientific research and graduate fellowships under the NASA Experimental Program to Stimulate Competitive Research (EPSCoR) -- Preparation Grant. Originally constructed as a one year program, with an optional one year continuation, this federal-state partnership culminated on 14 August 2002, including a successful continuation proposal and a no cost extension. The total value of the project reached \$450K in NASA funding, matched by state funds and institutional contributions. The purpose of the Preparation Grant program was to develop and nurture strong research ties between the state and NASA field centers and Enterprises, in order to prepare for the upcoming full competition for NASA EPSCoR.

The subprograms completed under this support were:

- 1) Graduate Student Fellowships - - "NASA EPSCoR Fellows"
- 2) Special Travel for Aerospace Researchers - - STAR
- 3) Development Grants for Aerospace Projects - - DGAP
- 4) Enabling Center Contacts - - ECC - - subtitled "Getting to Know Your NASA Centers."

These subprograms proved very successful. Three graduate students spent a summer conducting research at NASA Centers. Fourteen research awards were made under the DGAP program. Four researchers traveled to NASA Centers under STAR and a ECC workshop was held at ULL in 2000. NASA JSC also hosted an "EPSCoR Expo" visitation for participants from EPSCoR states. All scientific and technical objectives were met or exceeded.

This project was a trial of the model of building research capability through collaboration with NASA researchers. Overall the project was successful. Faculty were engaged in research and involved their students. Administrations improved their capabilities to handle grants and contracts. Faculty release time was granted, research space was provided and, in some cases, equipment was made available for the research. Some of the researchers are in the process of developing major new programs.

Acknowledgements

Bringing a project like this NASA EPSCoR Preparation Grant to a successful conclusion requires the coordinated activities of many individuals. It is with deep appreciation that we acknowledge the outstanding contribution of the Louisiana Board of Regents Staff, Louisiana State University, the research project Principal Investigators, Co-Investigators and their respective institutions. Also appreciated is the staff at NASA Headquarters. It is through the careful cooperation of this extended team that the Preparation Grant project achieved its stated goals and, in countless ways, contributed to the economic and research infrastructure development of the State of Louisiana. Last, but not least, thanks are due to the dedicated project management staff in the NASA EPSCoR office - - the Program Manager, Office Assistant, Web Master and Student Worker.

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FINAL PROJECT REPORT

"Louisiana NASA EPSCoR Preparation Grant"

This is the final report for the Louisiana NASA EPSCoR Preparation Grant (1999-2002). Presentations, publications, personnel, and assessment are presented in this narrative. Final technical reports from the research subawards are not reproduced here but are available for perusal. EPSCoR as a statewide, federal-state partnership was open to wide participation, on a merit-based review system, from all colleges and universities in the state.

I. PROJECT OVERVIEW

As the original NASA EPSCoR program came to a close, NASA planned to offer another major national competition. To help the eligible states prepare for this competition, in 1999 NASA issued a call for proposals for a "Preparation Grant." The overall goal of this "Preparation Grant," in addition to preparing Louisiana researchers to be competitive in the competition, was to establish strong linkages to researchers at the NASA Centers. This required a coupling of the interests/capabilities of LA researchers to those of researchers at different NASA Centers. Moreover, we need to develop long-term relationships and shared goals between the LA-based and the center-based researchers. In summary, one challenge was to (a) promote NASA related projects to LA researchers and their organizations, (b) to facilitate making appropriate connections with center researchers, and (c) to foster new or expanded collaborations between Louisiana and the NASA Centers.

NASA announced the Preparation Grant opportunity in 1999 and the award commenced on 15 August 1999 via Cooperative Agreement. Year 1 included a \$50K Fellowship component, which did not require state match. In January 2000, NASA offered a one year continuation, and Louisiana successfully proposed for the second year and received \$225K in NASA funds. Finally, a one year no cost extension brought the three year project to a close on 14 August 2002. This final cumulative report addresses the activities undertaken during the Preparation Grant.

Preparing the infrastructure of a state, and its researchers, for an eventual full EPSCoR proposal submission is a multi-faceted endeavor. The sub-programs described below enabled the necessary connections to be made throughout all levels.

- 1) Graduate Student Fellowships - - "NASA EPSCoR Fellows".
- 2) Special Travel for Aerospace Researchers - - STAR.
- 3) Development Grants for Aerospace Projects - - DGAP.
- 4) Enabling Center Contacts - - ECC - - subtitled "Getting to know your NASA Centers."

Several of these were patterned after existing programs in Louisiana supported by a variety of federal and state agencies. The difference here is the focus on 'Aerospace' areas (the five NASA enterprises) and NASA Center collaborations/contacts. The scientific/technical management component was conducted at LSU under the direction of Principal Investigator/Project Director John P. Wefel. Other management team members include Program Manager Karen Johnson, assistant Amy Eads, and web masters Doug Granger and Robby Perkins (student worker). Further, Roy Keller of the Louisiana Business and Technology Center, provided coordination and advice concerning technology transfer issues. The management team also manages the state-wide NASA Space Grant, and as such, acted upon NASA policy directives to seek opportunities for interaction between the two projects.

The Board of Regents served as the fiscal agent for this NASA EPSCoR Preparation Grant, as it does for other federal EPSCoR programs in Louisiana. The Board was the primary recipient of the NASA Cooperative Agreement and dispersed the funds to the individual institutions through subcontracts. Dr. Kerry Davidson, deputy Commissioner for Sponsored Programs, was responsible for overseeing all aspects of the BORSF commitment, as well as contractual and fiscal oversight related to the subcontracts awarded under this NASA EPSCoR Preparation Grant, at no cost to NASA. Dr. Doris Carver, Louisiana NSF-EPSCoR Project Director and Associate Commissioner for Sponsored Program Development, was responsible for overseeing the project as it relates to other EPSCoR and statewide programs, at no cost to NASA. Board staff members also devoted time in the contractual and fiscal administration of the award.

II. PROJECT ACCOMPLISHMENTS

The overall challenge for an EPSCoR state like Louisiana is to develop R & D areas that are both responsive to NASA's interests (as indicated in the R & D Compendium) and in line with state objectives and needs. Central to the NASA effort is forming strong linkages with NASA Center/Enterprise scientist/engineers, to develop cooperative projects. From among these, then, may emerge those that should go forward in response to a full competition.

The DGAP and Fellowship subprograms entailed statewide competitions. Projects were selected from among the many high quality proposals submitted. All projects had merit and were relevant to the NASA strategic enterprises. Each was reviewed by out-of-state experts who ranked them and recommended the ones to be funded. The STAR awards were made on a first-come, first-served basis.

A. NASA EPSCoR Fellows

This program, modeled after the successful LaSPACE Fellows and BOR Fellows programs, provided one calendar year of support (stipend) with the proviso that the student must spend at least 10 weeks at a NASA Center. Involving students, this program is, of necessity, tied to the academic year. It is not always possible for students to be away for extended periods during the semesters, so the center residence had to occur during the summer. (Using our start date of 15 August 1999 the students were a Fellow for AY 99-00 and spent the summer, 2000 at the selected NASA Center.) In addition to the stipend, we provided a supplement of \$5K which could be used to defray travel and living expenses while at the NASA Center. Any residual could be utilized for research related expenses. We supported three such fellows:

	<u>Name</u>	<u>University</u>	<u>Center</u>
1)	Lynne Valencic	Louisiana State University	NASA Goddard Space Flight Center

She studied "The Role of Dust in Starburst Galaxies" under the supervision of Prof. G. Clayton at LSU and Dr. Susan Neff at GSFC.

2)	Lionel Carrier	UL - Lafayette	NASA Langley Research Center
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His project entitled "Controller and Communication Integrity in Adverse Flying Conditions" was under the direction of Prof. F. Chowdhury of ULL and Dr. Celeste Belcastro of LaRC.

3)	Karen Crosby	Louisiana State University	NASA Marshall Space Flight Center
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Karen studied "Crystallographic Texture and Yield of Al-Cu-Li 2195" under Prof. Su-Seng Pang of LSU, working with Mr. Brett Smith at MSFC.

Lynne Valencic's project, "The Role of Dust in Starburst Galaxies," extended her work at LSU in the analysis of spectra taken of starburst galaxies from her observational program at Steward Observatory in January 2000. Most galaxies contain interstellar dust, but little is known about the distribution and characteristic of this dust, especially for distant galaxies. The role of dust in star formation is particularly important and can be studied in the starburst galaxies. Valencic continues working toward her Doctorate, expected in 2003.

Lionel Carrier carried out computer simulations using an F-14 aircraft model (MATLAB) and B-737 simulator obtained from Langley Research Center, in support of Prof. Chowdhury's

theoretical concepts. He worked at Langley testing the concepts in a digital signal processing lab. Two technical papers resulted and are published in conference proceedings. Carrier completed his Masters' Degree and took a job in the telecommunications industry. It is significant to note that an element of this work developed into one of the three successful research projects submitted to the NASA "EPSCoR 2000" national competition, with Dr. Chowdhury as Co-PI.

Karen Crosby investigated methods for joining composite materials to metal alloys with application to extreme conditions such as those found in offshore platforms or onboard spacecraft. Issues such as material selection, weight reduction, strength, thermal properties, and directional mechanical properties must be considered. A presentation and publication in proceedings of the Energy Sources Technology Conference & Exhibition resulted (ETCE 2001 - 17026). Karen Crosby received her PhD in August 2000. She is on the faculty of the Mechanical Engineering Department at Southern University in Baton Rouge.

While the students reported the great benefits of networking with government and industry scientists and gaining an understanding of the job environment, the logistics of temporary residence in terms of expense and dislocation, proved distracting. In some cases, the NASA Center personnel were also unprepared for short term visitors.

B. STAR – Special Travel for Aerospace Researchers

The key to building better ties with NASA Centers is to foster researcher to researcher communications. The major impediment to this has been, traditionally, lack of travel support, and STAR was designed to remove this impediment. STAR supported the travel of LA researchers to NASA Centers (for up to a week) to meet and interact with center research groups. It was intended to provide sufficient time for a detailed interchange of ideas and capabilities and for planning mutually beneficial projects.

The STAR sub-program was not as well utilized as anticipated. We were able to send Louisiana researchers to visit NASA researchers at MSFC, Langley, Ames and NASA Headquarters as follows:

	<u>Name</u>	<u>University</u>	<u>Center</u>
1)	Wen Jin Meng	Louisiana State University	NASA Marshall Space Flight Center

Dr. Meng visited the Nondestruction Evaluation and Tribology Group under R. L. Thom, met with four NASA Center researchers and toured the testing facilities.

2)	Fahmida Chowdhury	UL - Lafayette	NASA Langley Research Center
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Dr. Chowdhury gave a seminar at LaRC, toured the facilities, met with C. M. Belcastro and two other members of the group concerned with Aircraft Safety Improvements, and contacted the Office of Educational Opportunity. (This trip led to the ECC program described later.)

3)	Zeev Rosenzweig	University of New Orleans	NASA Ames Research Center
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Dr. Rosenzweig visited the 'Sensors 2000' group at ARC, meeting with M. Flint and J. Hines, and developed options for joint research. He was invited to return to ARC for follow-up discussions and proposal preparation.

4)	T. Gregory Guzik	Louisiana State University	NASA Headquarters
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Dr. Guzik attended the "NASA Office of Space Science Education and Public Outreach Conference 2000" in Chicago, IL, June 12-14, 2002. Reflecting the renewed NASA focus on education articulated by new NASA Administrator Sean O'Keefe, Dr. Guzik presented a poster on LSU E/PO (education and public outreach) and made contacts and gathered information that may prove crucial in defining new activities for LSU.

C. DGAP – Development Grants for Aerospace Researchers

The DGAP sub-program focused upon "getting people involved in research!" These were designed to be "seed" grants for research that has a demonstrated tie-in to a NASA Center. During the period of the award, the researcher was required to make one or more trips to the NASA Center to work with the NASA researcher who sponsored the project. There were two rounds of competition for DGAP awards.

The response to the DGAP offering in Year 1 was overwhelming. Within weeks we received a dozen proposals requesting, in aggregate, \$290K and offering \$196K in cost sharing. This was

over a factor of two beyond the resources available. Faced with this response, it was necessary to procure a group of reviewers to evaluate the projects and rank them for funding. For the second year of the Preparation Grant effort, we built upon the successes of the first year and focused the program into developing projects for future proposals.

Overall, the DGAP awards involved seven NASA Centers, at least 14 faculty members, ranging from new assistant professors to established researchers, plus one postdoctoral researcher. At least 12 graduate students and 8 undergraduate students were directly involved in the research. Additionally, the projects yielded 16 publications or conference proceedings, 11 presentations, one manuscript, and several successful follow-on proposals (see Section IV). The abstracts of the DGAP awards follow:

1999:

PI: Sumanta Acharya; Institution: Louisiana State University; Department: Mechanical Engineering; NASA Center: GRC

PROJECT TITLE: LARGE EDDY SIMULATIONS (LES) AND THEIR USE IN TURBULENCE MODELING FOR FILM COOLING OF TURBINE BLADES

ABSTRACT: Improved cooling strategies for gas turbine blades is currently one of the limiting technologies in the development of advanced gas turbine aero-engines. Thus considerable effort is being invested by NASA-Glenn in developing predictive design tools that can accurately predict the aero-thermal behavior for gas turbine blades. The proposed research is in direct support of this NASA mission. Film cooling of turbine blades, where coolant jets are injected directly over the blade surface, is one of the most commonly employed cooling strategies. However, predictive tools used by the gas turbine industry and NASA rely on using the Reynolds-Averaged-Navier-Stokes (RANS) calculation procedures with a turbulence model. Due to inherent inaccuracies in the model, these calculation procedures are unable to provide accurate predictions of the film cooling behavior. It is proposed herein to use Large Eddy Simulations (LES), where turbulence model is not introduced, and where all the energy carrying larger scales are resolved, to provide an understanding of the film cooling behavior, and to use these results to guide the development of turbulence models for use in RANS calculation procedures. The proposed work will be done in close collaboration with NASA-Glenn researchers since it dove-tails with their mission of developing improved predictive tools for gas turbine engines.

PI: Fernando Figueroa; Institution: Tulane University; Department: Mechanical Engineering;
NASA Center: SSC

**PROJECT TITLE: SENSOR BASED TAXONOMY FOR INTELLIGENT HEALTH
MONITORING SYSTEMS**

ABSTRACT: The PI is familiar with the test facilities at Stennis Space Center from the point-of-view of sensors and data acquisition (DAQ) systems. Although the facilities do an excellent job of testing the Space Shuttle Main Engine and other new engines and rocket motors, better performance could be achieved by implementing health-monitoring systems. This project will develop the taxonomy and implement a preliminary version of an Intelligent Health Monitoring System (IHMS). Such a system will infuse higher levels of productivity, integrity, and confidence in the operation of the test stands. To this end, a generic model of an intelligent sensor will be developed and sensor fusion algorithms will be implemented to diagnose if a sensor is faulty, to determine the fidelity of its value, and to prognosticate if sensor failure is eminent. The algorithms for sensor fusion will be based on analytical and qualitative methods (qualitative process theory and qualitative interpretation of system behaviors). The IHMS will improve overall integrity of the system, decrease the number of test failures, reduce the time spent in diagnosing problems, minimize unnecessary maintenance tasks, and increase the accuracy and integrity of the measurements. Although the proposed IHMS will focus on Stennis facilities, it will be based on generic modeling techniques and will find applications in virtually any industry with any level of automation (chemical, automotive, ship building, environmental, etc.)

PI: Mark J. Fink; Institution: Tulane University; Department: Chemistry;
NASA Center: GRC

PROJECT TITLE: NEW CVD PRECURSORS TO GALLIUM OXIDE THIN FILMS

ABSTRACT: Semiconductor materials are extremely important to NASA and the aerospace industry for the development of communication systems, photovoltaic power cells, low weight batteries, and high speed computing. The fabrication of state-of-the-art semiconductor devices often employs the deposition of thin films of semiconductor precursors using techniques such as chemical vapor deposition (CVD). A new class of potential CVD precursors to gallium oxide has been recently synthesized and characterized at Tulane University. Gallium oxide is important as a passivating layer to the semiconductor gallium arsenide, and also may be useful in the synthesis of multimetallic oxides with unusual electronic properties. The proposed one year project is a collaboration with Dr. Al Hepp at the NASA Lewis Research Center. Dr. Hepp is an internationally recognized scientist who leads an active program in thin film Solar Cells. His laboratory is fully equipped for the deposition and characterization of thin films. The project

involves 1) the synthesis and characterization of gallium siloxides as new CVD precursors (performed at Tulane) and 2) their deposition and evaluation as thin films at Lewis Research Center. The unique collaborative nature of the project is a blending of complimentary expertise (organometallic synthesis at Tulane and thin film technology at Lewis Research Center) which should lead to long term scientific relationship.

PI: Louis E. Roemer; Institution: Louisiana Tech University; Department: Electrical Engineering; NASA Center: SSC

PROJECT TITLE: DEVELOPMENT OF A SENSOR DESIGN BASED ON WHITE LIGHT INTERFEROMETRY

ABSTRACT: It is proposed that a white light interferometer be used as the basis of a vibration sensor design. Sensor design will be based on changing dimensions of a Fabry-Perot cavity, part of the optical signal processing system. The sensor would be fabricated using technology developed at the Institute of Micromanufacturing at Louisiana Tech University. It is also the intent of this proposal to examine the degree to which integrated optics can be incorporated into the signal processing part of the design to reduce costs of manufacturing. The success of the fabrication should be high, based on the current commercial development of white light interferometric systems. Interest by the NASA Test Directorate in low cost and reliable testing methodologies, and discussions with Dr. William St. Cyr of NASA SSC, encouraged this application. NASA would benefit from reduced costs of instrumentation associated with integrated microstructures. Further, using a uniform optical signal platform would tend to standardize data acquisition techniques and reduce costs.

PI: Harris Wong; Institution: Louisiana State University; Department: Mechanical Engineering; NASA Center: GRC

PROJECT TITLE: A THEORETICAL INVESTIGATION OF AN IDEALIZED MICRO HEAT PIPE

ABSTRACT: Micro heat pipes have been used as a heat-dissipating device in many systems, such as micro electronic components and the leading edge of hypersonic aircraft. Micro heat pipes transfer heat by evaporation, convection, and condensation, same as the conventional heat pipes. However, currently the effective thermal conductivity of micro heat pipes is only 1/40 that of conventional heat pipes. Due to the complexity of the coupled heat and mass transport, and to the complicated three-dimensional bubble geometry inside micro heat pipes, there is a lack of rigorous analysis. As a result, the relative low effective thermal conductivity remains unexplained. The principal investigator has conceptualized an idealized micro heat pipe that eliminates the

complicated geometry, but retains the essential physics. The simplified bubble geometry allows a direct comparison between theoretical predictions and experimental data. A preliminary investigation already reveals that the commonly accepted mechanism for driving the liquid flow is incorrect. Given the simplified geometry, many effects can be studied, such as thermocapillary flow, Marangoni immobilization, evaporation and condensation physics, and the relative size of vapor channel to liquid channel. The objective of this research is to identify the key parameters governing the transfer of heat in micro heat pipes. The results will be used to guide the design of micro heat pipes so as to improve their heat transfer efficiency.

PI: Jianchao Zhu; Institution: Louisiana State University; Department: Electrical and Computer Engineering; NASA Center: MSFC

PROJECT TITLE: FURTHER STUDY ON NASA'S X-33 FLIGHT CONTROLLER DESIGN USING TRAJECTORY LINEARIZATION

ABSTRACT: The Reusable Launch Vehicle (RLV) concept is NASA's approach to reliable and affordable routine space transportation - a corner stone of the four NASA's "Strategic Enterprises." The X-33 is a technology demonstrator for the RLV concept which promises to reduce the cost of routine space transportation by a factor of ten within the next decade. Current flight control techniques are largely based on gain scheduling of linear time-invariant controllers, which are challenged by the stringent tracking and decoupling control requirements in high angle-of-attack and rapidly changing flight conditions for RLV. NASA MSFC is currently evaluating available robust, multivariable nonlinear control theories and techniques for application to the RLV flight control system. NASA-BOR DGAP support is requested to further the PI's study on NASA's X-33 flight controller design using trajectory linearization approach that was initiated with a 1998 LaSPACE Research Facilitation/Initiation Award. During subsequent 1999 NASA/ASEE Summer Faculty Fellowship Program (SFFP) at NASA MSFC, the PI designed an ascent flight controller for X-33 using the proposed method. Three-DOF simulations showed great promise in improving performance, robustness and scalability, and in reducing design and mission reconfiguration time and costs. The objectives of this project are: (i) further testing and refining the ascent flight controller for X-33 with high fidelity 6-DOF simulations, (ii) designing a descent flight controller for X-33 that is more challenging than the ascent controller, (iii) developing a full scale research proposal based on (i) and (ii) to be submitted to the upcoming NASA EPSCoR Program. If successful, the proposed controller design technique could save up to \$12M in the X-33 flight test phase from reduced mission reconfiguration time and work.

2000:

PI: Terrence L. Chambers; Institution: University of Louisiana - Lafayette; Department: Mechanical Engineering; NASA Center: JPL

PROJECT TITLE: INTELLIGENT SYMBOLIC REGRESSION FOR ENGINEERING OPTIMIZATION MODELS

ABSTRACT: This proposal describes a new technique for performing automatic symbolic regression on engineering data generated either by experimentation or by sampling computationally expensive analysis models. The algorithm simulates human intelligence by combining Genetic Programming and Neural Networks, so that the combination is more versatile and effective than either method by itself. The symbolic regression method described herein can be used to simplify complex engineering models so that optimization will be less expensive, or to create a symbolic model from experimental data. This research will benefit the aerospace industry by providing a more efficient way to perform design optimization. The efficiency of the proposed method will be tested on a set of standard optimization test problems. The proposed work is directly related to a NASA-wide effort called the Intelligent Synthesis Environment (ISE), which is geared partly toward developing the next generation of design synthesis tools. The proposed research will help develop a more efficient design synthesis tool. Contact has been established with two NASA "sponsors," at the Johnson Space Center (JSC) and the Jet Propulsion Laboratory (JPL) respectively, who confirm that the proposed project is of interest to them, and that it is applicable to the ISE project.

PI: Kathleen S. Cole; Institution: University of Louisiana - Lafayette; Department: Biology; NASA Center: JSC

PROJECT TITLE: SKELETAL FORMATION AND SPATIAL ORIENTATION IN RIVULUS MARMORATUS FOLLOWING EXPOSURE TO BIOREACTOR CONDITIONS DURING EMBRYONIC DEVELOPMENT

ABSTRACT: As NASA develops missions involving longer term exposure to space conditions, understanding the effects of prolonged microgravity on a variety of biological processes will become increasingly important. To date, studies have indicated that the absence of gravitational cues can adversely affect a variety of biological processes at the cell, tissue and organ level. The ground-based NASA bioreactor has been used as an analogue for microgravity conditions experienced during spaceflight for some of these studies, often to examine responses of cells and cell clusters. However, the bioreactor can also be used to address similar questions in the context

of tissue and organ formation in developing embryos. *Rivulus marmoratus* is a small-sized, self fertilizing fish which produces homozygous, isogenic offspring. Upon release, the fertilized eggs are negatively buoyant and the egg case is non-adhesive, making *R. marmoratus* embryos ideally suited to bioreactor conditions. The specific objectives of this study are to examine the effects of exposure to simulated microgravity conditions, using a bioreactor as a ground-based analogue, on the development of genetically identical fish embryos. The investigation will focus on two aspects of embryonic development, including (1) formation of skeletal elements, and (2) post-hatch spatial orientation in response to normal gravity cues.

PI: Michael Dagg; Institution: Louisiana Universities Marine Consortium;
NASA Center: SSC

PROJECT TITLE: PICOPLANKTON AND OPTICAL CHARACTERIZATION OF SURFACE WATERS IN THE NORTHERN GULF OF MEXICO

ABSTRACT: A primary goal of the NASA's Earth Science Enterprise is to improve assessment of the global biogeochemical cycle of carbon. The magnitude and nature of carbon storage in shelf sediments is an important constraint on the global CO₂ budget. Within the oceanic environment, deltaic shelves make a particularly important contribution to global carbon cycling because approximately 80% of the total organic carbon preserved in marine sediments occurs in deltaic regions near the mouths of large rivers such as the Mississippi River. The major source of this carbon is phytoplankton production. Satellite sensed ocean color provides the only practical means of monitoring the spatial and temporal variability of near-surface phytoplankton in open ocean and coastal environments. Dr. Richard Miller of NASA SSC is currently using a ship-deployed suite of instruments to optically characterize surface waters in the northern Gulf of Mexico, in order to improve ocean color algorithms used for remotely monitoring river-dominated margins, e.g. SeaWiFs. The objective of this proposal is to provide detailed information on the abundance, distribution and type of autotrophic picoplankton in these coastal waters, in cooperation with ongoing studies by Dr. Miller. These picoplankton affect optical properties of coastal ocean water by their photosynthetic pigments and by their high surface to volume ratio.

PI: Mark J. Fink; Institution: Tulane University; Department: Chemistry;
NASA Center: GRC

PROJECT TITLE: SEMICONDUCTOR THIN FILMS FOR ADVANCED PHOTO-VOLTAICS

ABSTRACT: Thin film photovoltaics for solar energy conversion are a critical technology for NASA. They promise to provide the high power output, the low weight and packaging volume, and radiation resistance necessary for short and long term space missions. The fabrication of these

state-of-the-art semiconductor devices often employs the deposition of thin films of semiconductor materials on light weight polymers using techniques such chemical vapor deposition (CVD). The chalcopyrites, $\text{Cu (Ga, In)(S, Se)}_2$, are amongst the most efficient and promising of the semiconductor materials to be used in thin film photovoltaic devices. This project addresses the development of CVD precursors for the efficient formation of chalcopyrite thin films. The proposed one year project is a collaboration with Dr. Al Hepp at the NASA John Glenn Research Center. Dr. Hepp is an internationally recognized scientist who leads an active program in thin film Solar Cells. His laboratory is fully equipped for the deposition and characterization of thin films and their implementation in photovoltaic devices. The project involves 1) the synthesis and characterization of volatile single source precursors to chalcopyrite semiconductors (performed at Tulane) and 2) their deposition and evaluation as thin films at Glenn Research Center. The unique collaborative nature of the project is a blending of complimentary expertise (organometallic synthesis at Tulane and thin film technology at the Glenn Research Center) and supports a fruitful scientific relationship between the investigators.

PI: Michael M. Khonsari; Institution: Louisiana State University; Department: Mechanical Engineering; NASA Center: GRC

PROJECT TITLE: FAILURE ANALYSIS OF MECHANICAL COMPONENTS INVOLVING THERMOELASTIC DEFORMATION AND SQUEEZE

ABSTRACT: This proposal aims at developing a new collaborative research program between the PI and his research group from the Mechanical Engineering Department at LSU and David Brewster at NASA Glenn Research Center. Seed funding is requested in order to develop a long-range joint research program with NASA. In particular, results of this initiation research program are expected to form the basis for the next round of NASA-EPSCoR competition grants at the national level. Consistent with NASA's Strategic Enterprise objectives, this proposal addresses the needs of the newest Propulsion Systems project known as ULTRASAFE Engine (Engine Failure Containment). The thrust of Rotorcraft Drive System Technology calls for advanced designs of transmissions, gearboxes, bearings, and lubricants with appropriate modeling and design rules to allow ultra-safe operation. Specifically, the proposed research addresses the failure and performance analyses of a number of vital mechanical engine components that undergo hydrodynamic squeeze motion. Excessive thermoelastic deformation causes warping of the conducting surface which leads to a form of failure known as disc coning. Recent research with high-speed photography shows that cavitation bubbles do indeed appear on the surface of fluidic components during their operation. Not only does the occurrence of cavitation affect the performance of the system, but there is also strong evidence that this process may contribute to the formation of the macroscopic hot spotting known to occur on the surfaces of seals and wet clutches. Often referred to as thermoelastic instability, the formation of these hot spots leads to

serious material degradation and hence is known to be a failure mechanism. In a mechanical seal for example, this may lead to excessive leakage and catastrophic breakdown. Yet, the precise phenomenon responsible for the formation of hot spots and the eventual failure is not well understood. A joint research with duration of ten-months is proposed to perform thermoelastic analysis of transmission components in collaboration with David Brewster's team at NASA Glenn Research Center. Once a realistic simulation analysis has been developed, a factorial design analysis, known as the analysis of variance (ANOVA), can be carried out to quantify the main and interaction effects of operating conditions and material parameters on the performance parameters. ANOVA would provide the designer with a powerful tool to make breakthrough improvement in efficiency, reliability, and performance of the engine components. There are a number of branches at NASA that may be interested in our long-term collaboration on a variety of rotor-craft issues in accordance to NASA's Mission for ULTRA-SAFE ENGINE design.

PI: Aravamudhan Raman; Institution: Louisiana State University; Department: Mechanical Engineering; NASA Center: GRC

PROJECT TITLE: HIGH TEMPERATURE MATERIALS RESEARCH - STUDY OF ELASTIC ANOMALY AND GRAIN AGGLOMERATION FEATURES IN THE SUPERALLOY IN738LC

ABSTRACT: Advanced high temperature materials (HTM) such as superalloys are of primary import toward the development of higher efficiency aero-space engines that will operate at temperatures few hundred degrees above those being operated now. Single crystal and nanocrystalline HTMs are currently being developed and characterized. The purpose of this project is to further characterize and explain the elastic hardening found at high temperatures in the superalloy IN738LC and to understand the precipitate agglomeration found in the precipitated alloys when annealed at temperatures in the range 700 - 1120°C. These topics are of fundamental importance in determining the high temperature design and performance of the HTMs. The project shall be carried out in collaboration between LSU and SU (a minority institution) in Baton Rouge and the NASA Glenn Research center in Cleveland, OH, with the group of Dr. Michael V. Nathal, Chief of the Advanced Metallics Branch, Materials Division. The results obtained will support the interests of, and initiatives in, the NASA Strategic Enterprise Category: Aerospace Technology. The proposed project is expected to lead also toward a broader effort on nanocrystalline HTM development with the NASA Research Laboratory through a LA-NASA EPSCoR project in the near future.

PI: Zeev Rosenzweig; Institution: University of New Orleans; Department: Chemistry;
NASA Center: ARC

**PROJECT TITLE: DEVELOPMENT OF DIGITAL FLUORESCENCE TECHNIQUES FOR
THE ANALYSIS OF LIFE FORMS COLLECTED FROM EXTREME ENVIRONMENTS**

ABSTRACT: This proposal covers the development of microbiological analytical protocol development in support of the Astrobiology Hydrothermal Vent program. The study of terrestrial analogs to extraterrestrial environments affords an opportunity to develop the background necessary to undertake the search for extraterrestrial life. Such research can expand our understanding of what constitutes "life" and define the limits to terrestrial life. This proposal focuses on the development of fiber optic based fluorescence techniques, which are designed to enable fundamental research into the limits of life in extreme environments. The analytical protocols utilize digital fluorescence imaging technology, recently developed by Dr. Rosenzweig (the project director) and his co-workers at the University of New Orleans. During the proposed seeding study the parameters controlling the analytical performance of the newly developed fiber optic fluorescence microscopic technique will be optimized. The technique will be used to examine samples collected from hydrothermal vents for the presence of unique life forms with respect to membranes, proteins, nucleic acids and pigments in the laboratory. Future studies will focus on the development of an instrument with *in situ* measurement capabilities. This work will provide an analog to the environments and technologies required for astrobiological exploration of the solar system.

PI: J. Jim Zhu (Nikitopoulos); Institution: Louisiana State University; Department: Engineering Research; NASA Center: LaRC

PROJECT TITLE: FEASIBILITY STUDY OF A ROADABLE AIRCRAFT

ABSTRACT: The aviation industry and the general transportation industry are facing great challenges at the dawn of the 21st Century — the "hub-lock" and the "gridlock." While the aviation has gone a long way since the Wright Brothers first powered flight, the sky remains beyond the reach by the general public as a mode of personal transportation and recreation. To answer these urgent challenges, an Aeromobile and 3-Dimensional Interstate Highway Transportation System concept was proposed. That concept consists of two major components: (1) the aeromobile vehicle that has satisfactory road handling qualities and ride comfort as a highway vehicle, and that is meanwhile a VTOL, wingless (lifting body) aircraft with automated flight operation, navigation and communication system providing safe and comfort flying experience; and (2) the 3D highway transportation infrastructure that provides intelligent and integrated roadways, airways and intersections of such, 3D traffic management, control, navigation and

signaling, services and conveniences, emergency handling, and law enforcement patrol. It appears that the viability of that concept hinges mainly on the feasibility of the envisioned VTOL, wingless aeromobile vehicle. An evolutionary approach to the research and development of an aeromobile named Pegasus was proposed. The first step is to develop a CTOL, winged convertible flying automobile, the Pegasus I. Research focus for this stage is on the maximal dual use of system components and optimal design of the lifting-body fuselage and high-lift wings. Passive and active lift augmentation devices will be applied to reduce the size of the wings and eventually eliminate them. Novel powered lift techniques will be developed for future incarnations of the Pegasus to enable VTOL/STOVL capability. In this study we will examine the feasibility of the Pegasus I conceptual design with an emphasis on low speed lift augmentation techniques. Experimental studies will be conducted to demonstrate the concept of regenerative supercirculation and to evaluate its potential as a powered lift technology for STOL and VTOL aircraft and for the aeromobile.

D. ECC – Enabling Center Contacts

The fourth sub-program is directed at educating the state's researchers, particularly new, young faculty, about work being done at NASA Centers. Ideally, we would like to have a large number of researchers visit the centers to both see the facilities and interact, one-on-one, with center researchers. Logistically, this is not always possible. One alternative is to bring the "Center" to Louisiana for mini-workshops. These mini-workshops are designed for two-way communication, finding out about the center programs and interests plus describing the Louisiana capabilities and interests to the center personnel. A third alternate, most saving of center resources, is to schedule a "NASA EPSCoR Day" at the centers for regional groups of states, or even the full 20 EPSCoR states.

We have had mixed success with ECC. We conducted one mini-workshop (27 March, 00) involving Center personnel from Langley, augmented by representatives from Stennis. This one-day "workshop" that highlighted on-going work at the two centers and allowed one-on-one interaction. This workshop, organized by Dr. Fahmida Chowdhury, Department of Electrical and Computing Engineering at the University of Louisiana at Lafayette (ULL) was held at the ULL Alumni Center. All campuses were invited to send representatives.

For the other centers, we ran into a problem. Basically, the Center personnel do not have the time to visit the states, especially considering that there are 20 EPSCoR states. Rather, the Centers suggest that we schedule a 1 - 2 day visit with them for 2 - 3 people from each EPSCoR state. This came to fruition for JSC with the "EPSCoR Expo" held on May 8 - 9, 00. Interest in such an event had also been expressed by JPL and SSC, but no firm plans developed. Note that we have already

had a "Louisiana Day" at SSC in the fall of 1999. In addition, representatives attended the GSFC 'open house' and the JSC 'Inspection.'

III. OVERALL PROGRAM ASSESSMENT

Overall, the Preparation Grant worked effectively. We have had contacts with eight of the NASA Centers: GSFC, LaRC, ARC, MSFC, GRC, JSC, SSC and JPL as well as NASA HQ. Working with these NASA contacts were researchers or graduate students from six Louisiana universities: LSU, Tulane, ULL, LaTech, UNO and LUMCON. In addition to the three NASA EPSCoR Fellows, twelve other graduate students worked on one of the DGAP projects, and two have been awarded degrees, one masters and one Ph.D. Adding the two fellows who graduated, Carrier (MS) and Crosby (Ph.D.), four advanced degrees have resulted, so far, from the Preparation Grant projects, and others are in the pipeline. Further, one post-doctoral associate and at least eight undergraduate students were trained as part of the overall effort.

The R & D areas were diverse, ranging from Astrophysics to Aeronautics and to many facets of Aerospace Technology. The latter accounted for the preponderance of Code R centers as collaborators, with GRC having the largest presence. However, two of the projects with SSC were connected to Propulsion testing, one project involved astrobiology and another was in space life sciences. This attests to the breadth of the research interests and capabilities among Louisiana researchers.

It should be noted that the DGAP and Fellows subprograms were selected by out-of-state reviewers in an open competition from twice as many submissions, many of which were equally worthy of support. Thus, there remains a reservoir of good projects, and NASA collaborations, which could not be supported under this preparation grant. Louisiana has the capacity to develop major NASA related programs.

The scientific/technical management portion of the overall project proceeded successfully throughout all project phases. Numerous contacts were developed with state and federal agencies and with private industry and non-profit groups, and especially NASA Centers. Such contacts both benefited the overall program and remain important for future endeavors. Another major event was the statewide conference, sponsored by the state EPSCoR committee. In addition to valuable plenary sessions, there was a specific NASA session, at which the NASA EPSCoR Preparation project was presented.

A particular emphasis was placed on Technology Transfer awareness. Even though the research projects did not reach a level where there were specific products or licensing agreements,

in anticipation, the project involved Roy Keller, the director of the Louisiana Department of Economic Development's Technology Transfer Office, operated by the Business and Technology Center at LSU in collaboration with the Stennis Space Center. His objective was to educate the researchers about the availability and methodology of technology transfer and to be aware of developments in the research.

Perhaps the best measure of the success of this Preparation Grant is the fact that two of the three research areas which were selected in the NASA EPSCoR-2000 competition had their roots in DGAP awards. The third research team selected for Louisiana EPSCoR-2000 was nurtured, previously, through a Space Grant seed project award. These three NASA EPSCoR-2000 research teams are hard at work building new expertise, while the EPSCoR-2000 infrastructure component is attempting to stimulate new R & D for the future. This is the legacy of Cooperative Agreement NCC5-393.

IV. PROJECT DOCUMENTATION

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